

CLAIMS

1. A method for diagnosing degradation of a lean exhaust gas aftertreatment system, the system including a NOx catalyst having a first NOx sensor coupled upstream of the catalyst and a second NOx sensor coupled downstream of the catalyst, the method comprising:

comparing a first NOx sensor measurement and a second NOx sensor measurement when the catalyst is within a first predetermined temperature range; and

providing an indication of system degradation when a difference between said first NOx sensor measurement and said second sensor measurement is greater than a second predetermined value.

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2. The method as set forth in Claim 1 wherein the NOx catalyst is an SCR catalyst.

3. The method as set forth in Claim 2 wherein said second predetermined value is substantially zero.

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4. The method as set forth in Claim 3 further comprising estimating an amount of NOx in an exhaust gas mixture entering said SCR catalyst.

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5. The method as set forth in Claim 4 wherein said indication of system degradation comprises indicating a first NOx sensor degradation if a difference between said first NOx sensor reading and said estimate is greater than a third predetermined value and indicating a second NOx sensor degradation otherwise.

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6. The method as set forth in Claim 5 wherein said first predetermined temperature range is a temperature range wherein a NOx conversion efficiency of the catalyst is substantially zero.

7. The method as set forth in Claim 6 wherein the catalyst is an Active Lean NOx Catalyst (ALNC).

8. The method as set forth in Claim 1 wherein said first predetermined temperature range is a temperature range below 150°C.

9. The method as set forth in Claim 1 wherein said first predetermined temperature range is a temperature range above 450°C.

10. The method as set forth in Claim 1 wherein the catalyst is a Lean NOx Trap (LNT).

11. The method as set forth in Claim 1 wherein the catalyst is a Lean NOx trap (LNT).

12. The method as set forth in Claim 11 wherein said first predetermined temperature range is a temperature range wherein there is substantially no NOx conversion or adsorption in said LNT.

13. A diagnostic system, comprising:
a lean burn internal combustion engine;
a NOx catalyst coupled downstream of said engine;

a first NOx sensor providing a measurement of an amount of NOx in an exhaust gas mixture entering said catalyst;

5 a second NOx sensor providing a measurement of an amount of NOx in an exhaust gas mixture exiting said catalyst; and

a controller comparing said first NOx sensor measurement to said second NOx sensor measurement when a catalyst temperature is within a predetermined
10 temperature range and providing an indication of system degradation based on said comparison.

14. The system as set forth in Claim 13 wherein said NOx catalyst is an SCR catalyst.

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15. The system as set forth in Claim 13 wherein said NOx catalyst is an ALNC catalyst.

16. The system as set forth in Claim 13 wherein
20 said NOx catalyst is an LNT.

17. The system as set forth in Claim 13 wherein said predetermined temperature range is a temperature range below 150°C.

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18. The system as set forth in Claim 13 wherein said predetermined temperature range is a temperature range above 450°C.

30 19. The system as set forth in Claim 13 wherein said catalyst temperature is determined based on a temperature measurement downstream of said catalyst.

20. The system as set forth in Claim 19 wherein said catalyst temperature is further determined based on a temperature measurement upstream of said catalyst.

5 21. The system as set forth in Claim 13 further comprising estimating an amount of NOx in said exhaust gas mixture entering said catalyst.

22. The system as set forth in Claim 21 wherein
10 said estimating is performed based on engine operating conditions.

23. The system as set forth in Claim 22 wherein said engine operating conditions comprise an engine
15 speed.

24. The system as set forth in Claim 23 wherein said engine operating conditions further comprise an engine load.
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25. The system as set forth in Claim 24 wherein said engine operating conditions further comprise an engine temperature.

25 26. The system as set forth in Claim 25 wherein said controller further differentiates between said first NOx sensor and said second NOx sensor as a cause of said system degradation by providing an indication of said first NOx sensor degradation if a difference between said
30 first NOx sensor measurement and said estimated amount of NOx in said exhaust gas mixture entering said catalyst is greater than a second predetermined value; and

providing an indication of said second NOx sensor degradation otherwise.

27. A method for diagnosing degradation of an γ emission control system coupled downstream of an internal combustion engine, the system including a NOx catalyst having a first NOx sensor coupled upstream of the catalyst and a second NOx sensor coupled downstream of the catalyst, the method comprising:

providing an indication of an operating condition;

in response to said indication diagnosing the first NOx sensor degradation if a difference between a first NOx sensor signal and an estimated amount of NOx in an exhaust gas mixture upstream of the catalyst is greater than a first predetermined value; and

diagnosing the second NOx sensor degradation if a difference between a first NOx sensor signal and an estimated amount of NOx in an exhaust gas mixture upstream of the catalyst is less than said first predetermined value and a difference between said first NOx sensor signal and a second NOx sensor signal is greater than a second predetermined value.

28. The method as set forth in Claim 27 wherein the NOx catalyst is an SCR catalyst.

29. The method as set forth in Claim 27 wherein the NOx catalyst is an ALNC catalyst.

30. The method as set forth in Claim 27 wherein said NOx catalyst is an LNT.

31. The method as set forth in Claim 30 wherein said operating condition is a temperature of said LNT wherein there is substantially no NOx conversion or adsorption in said LNT.

32. The method as set forth in Claim 27 wherein said operating condition is a catalyst temperature below 150°C.

5 33. The method as set forth in Claim 27 wherein said operating condition is a catalyst temperature greater than 450°C.

34. A method for diagnosing degradation of an⁴
10 emission control system coupled downstream of an internal combustion engine, the system including a NOx catalyst having a first NOx sensor coupled upstream of the catalyst and a second NOx sensor coupled downstream of the catalyst, the method comprising:

15 providing an indication that a catalyst temperature is within a predetermined window;

in response to that indication, differentiating between the first NOx sensor and the second NOx sensor as a cause of the emission control system degradation based
20 on an estimate of an amount of NOx in an exhaust gas mixture entering the catalyst, a first NOx sensor and a second NOx sensor reading.

35. An article of manufacture, comprising:
25 a computer storage medium having a computer program encoded therein for use with an emission control system for an internal combustion engine, said emission control system including a lean exhaust gas aftertreatment device and a reductant injection system injecting a reductant
30 into said lean exhaust gas aftertreatment device, said computer program comprising:

code for providing an indication that a device temperature is within a predetermined temperature window; and, in response to that indication, differentiating

between the first NOx sensor and the second NOx sensor as
a cause of the emission control system degradation based
on an estimate of an amount of NOx in an exhaust gas
mixture entering the catalyst and on a comparison of a
5 first NOx sensor reading to a second NOx sensor reading.

36. A diagnostic system, comprising: 6
a lean burn internal combustion engine;
a NOx catalyst coupled downstream of said engine;
10 a NOx sensor providing a measurement of an
amount of NOx in an exhaust gas mixture exiting said
catalyst; and
a controller estimating an amount of NOx in an
exhaust gas mixture entering said catalyst based on
15 engine operating conditions, said controller comparing
said estimate to said NOx sensor measurement when a
catalyst temperature is within a predetermined
temperature range and providing an indication of system
degradation based on said comparison.

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37. The system as set forth in Claim 36 wherein
said NOx catalyst is an SCR.

38. The system as set forth in Claim 36 wherein
25 said NOx catalyst is an ALNC.

39. The system as set forth in Claim 36 wherein
said predetermined operating temperature range is below
150°C.

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40. The system as set forth in Claim 36 wherein
said predetermined operating temperature range is above
450°C.

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41. A method for diagnosing degradation of a NOx sensor coupled downstream of a NOx catalyst, comprising:
estimating an amount of NOx in an exhaust gas mixture entering the catalyst based on operating
5 conditions;
comparing said estimate to a NOx sensor signal when a catalyst temperature is within a predetermined range; and
providing an indication of the NOx sensor
10 degradation based on a result of said comparison.

42. The method as set forth in Claim 41 wherein said indication of degradation is provided when a difference between said estimate and said NOx sensor
15 signal is greater than a small calibratable value.